Original Research Article

Aloe vera bio-extract coating results better shelf life and fruit quality attributes in pomegranate

ABSTRACT

Aims: To evaluate the potentiality of bio-extract coatings for achieving extended shelf life with enhance fruit quality attributes in pomegranate under ambient storage condition.
Study design: The lab experiment conducted in complete randomized design with three repetitions on *Mridula* cultivar of pomegranate.
Place and duration of study: The experiment was conducted during September 2016 at department of fruit science, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India.
Methodology: Pomegranate freshly harvested fruits were coated with three bio-extracts coatings *viz. Aloe vera (50,75 and 100%),* ginger (1,2 and 3%) and mints (10,20 and 30%). The coated fruits were stored at ambient room condition in corrugated fiber board boxes for twelve days. Periodically effects of bio-extract coatings, storage period and their interaction were observed for physiological loss in weight, decay loss, juice content, TSS: acid ratio, ascorbic acid content and anthocyanin content.
Results: Surface coating with *Aloe vera* extract 100% was found most effective in reducing physiological loss in weight (50% less reduction as compared to untreated control) whereas ginger extract 3% in reducing the decay loss of fruits (9.65%) as compared to untreated control (23.36%). Among various treatments, the coating of pomegranate fruits with *Aloe vera* extract 100% resulted in lowest total soluble solids to acid ratio (32.17%) and significantly highest content of juice (47.17%), anthocyanin (13.98 mg/100g) and ascorbic acid (12.82 mg/100g) of the fruits along with highest organoleptic rating. The quality attributes *viz.* total soluble solids to acid ratio, anthocyanin of fruits increased with progression of storage period, while juice content and ascorbic acid decreased.
Conclusion: Bio-extract coating of *Aloe vera (100%) substantially improved the shelf life with retaining better fruit quality attributes under ambient conditions and has the potential to substitute the prevalent chemical coatings for pomegranate.*

Key words*: Pomegranate, bio-extract coatings, shelf life, organoleptic rating, quality attributes*

1. INTRODUCTION

Pomegranate (*Punica granatum* L.) a non-climacteric many seeded berry of Punicaceae family, is popularly known as *Anar* in India. Its cultivation is a highly lucrative and remunerative agriculture business in the country. The alluring monetary return per unit area, unique sensory and nutritional properties coupled with medicinal benefits has resulted in steady increase in area, production, consumption and export of pomegranate during last two decades. Pomegranate has poor processing quality and is therefore, mainly used for table purpose only. Under these circumstances, handling and marketing become important to provide remunerative prices to the growers. The post-harvest losses in pomegranate occur due to improper handling and lack of packing material during transport [1]. Extension of shelf life can be achieved by checking the rate of transpiration, respiration and microbial infection. Although the use of various chemicals and waxing materials at pre- and post-harvest stages of fruits are already suggested and adopted by the growers but the application of these substances is believed to be unsafe and may have direct effect on human health. Hence, there is an urgent need to substitute the ecologically and economically unsafe substances with substances of biological origin with similar effect. The present experiment aims to explore and evaluate the efficiency and efficacy of bio-extract coatings to enhance shelf life with retaining better fruit quality of pomegranate. In the study botanical formulations of *Aloe vera*, ginger and mint were used as these are the most definite alternative to overcome the undesirable effects of chemicals [2] and an alternative to the use of post-harvest chemical treatments leading to the increment in shelf life of fruits.

2. MATERIALS AND METHODS

2.1 Experimental location

The experiment was carried out in Post-harvest Technology Laboratory of the Department of Horticulture, CCS Haryana Agricultural University, Hisar during 2016.

2.2 Collection of pomegranate

Pomegranate (*Punica granatum* L. cv. Mirdula) fruits were harvested at the commercial ripening stage from the Centre of Excellence for Fruits, Mangiana (Haryana), India. Immediately, the same day fruits were transported to laboratory of Department of Horticulture, CCS Haryana Agricultural University, Hisar. Pomegranate fruits were selected for uniformity in size (300–350 g), shape and colour. Diseased, sunburn, bruised and injured fruits were discarded. The remaining fruits were randomized and divided into ten lots of 30 fruits for the following treatments in three replicates (each replicate contained 10 individual fruits).

2.3 Experimental design and treatments

The experiment was laid out in completely randomized design (CRD) with three repetitions and consisting of ten treatments comprising of bio-extract coatings (*Aloe vera*- 50, 75 and 100%, ginger- 1, 2 and 3% and mint- 10, 20 and 30%) and untreated control. In the experiment ten freshly harvested fruits were assigned per treatment per repetition. The fruits were stored at room temperature with maximum 29±2℃, minimum 12±2℃ and relative humidity 90±5%.

2.4 Collection of plant material and preparation of bio extract coatings

The plant material for preparation of coatings were collected from respective crop research farm of the university and freshly harvested leaves of *Aloe vera*, and mint and rhizomes of ginger were used for preparation of bio extract coating on the same day. The mature leaves of *Aloe vera* plants were washed twice with distilled water. The latex was then collected from the outer cortex of leaves by keeping it for two hours in vertical position and then the colourless hydro-parenchyma was ground in a blender. The resulting mixture was filtered to remove the fibres. The liquid obtained, constituted fresh *Aloe vera* gel (100%) and it was further diluted with distilled water in1:1 ratio (50% *Aloe vera* extract) and in 3:1 ratio (75% *Aloe vera* extract). Similarly ginger extract was obtained by washing, peeling, grinding the rhizome and dissolving 10, 20 and 30 ml of strained ginger extract in distilled water and final volume was made to 1 litre to prepare 1, 2 and 3% of ginger extract, respectively. Mint leaves extract was prepared by dissolving 100, 200 and 300 ml of leaf extract in distilled water and final volume was made to 1 litre to prepare 10, 20 and 30% of mint extract, respectively. Fruits were coated as per the treatments by dipping in treatment wise solution for 5-10 min. Coated fruits then allows for air drying at ambient conditions and then stored in corrugated fibre board boxes (30 x15x20 cm^3).

2.5 Data collection

Physiological loss in weight during storage was calculated by subtracting the final fresh weight (12^{th} day of storage) from the initial fresh weight (0 days of storage) of the fruits. Cumulative weight losses were expressed as a percentage loss of original weight. The decay loss was calculated by subtracting the number of decayed fruits (fruits with visible sign of any fungal / bacterial growth) from the total number of fruits. The pomegranate juice content (%) was calculated by dividing the juice volume by fruit weight. Ascorbic acid was determined as per the method suggested by AOAC [3], while total anthocyanin was determined according to the pH differential spectroscopic method [4, 5]. The stored fruits were subjected to sensory evaluation by a panel of six judges using the 9 points Hedonic rating scale for colour, texture, appearance and flavour [6] and treatment with mean scores of 6 or more out of 9 marks were considered as acceptable quality.

2.6 Data analysis

Various observations related to the quality of the stored fruits were recorded at three days interval from days of storage to 12 days of storage. The overall significance of difference amongst the treatments was tested, using critical differences (C.D.) at 5% level of significance [7]. The results were statistically analyzed with the help of a windows based computer package OPSTAT [8].

3. RESULTS AND DISCUSSION

3.1 Physiological loss in weight (%)

The data presented in Figure 1 clearly indicate that the bio-extract coating treatments significantly affected the physiological loss in weight of pomegranate fruits. Under ambient room conditions, the significantly minimum loss in weight 3^{rd}, 6^{th}, 9^{th} and 12^{th} day under storage was observed in pomegranate fruits coated with *Aloe vera* extract 100%, (1.85, 2.93, 4.70 and 6.32% on 3^{rd}, 6^{th}, 9^{th} and 12^{th} day of storage respectively) as compared to all other treatments. The maximum loss in weight was recorded from untreated pomegranate fruits, (5.12, 7.25, 10.31 and 12.61% on 3^{rd}, 6^{th}, 9^{th} and 12^{th} day of storage respectively). The different coatings of ginger and mint were not exhibiting any substantial improvement over untreated control and remain statistically at par. *Aloe vera* extracts 75%, which was at par with *Aloe vera* extract 50%. As the *Aloe vera* gel retarded moisture loss and

reduced respiration rates, these effects attributed for observing less reduction in physiological loss in weight and similarly to other edible coatings [9]. In mango also, *Aloe vera* gel coating significantly reduced weight loss during fruit ripening and low temperature storage as compared to uncoated fruits [10]. Similar effects of *Aloe vera* coating also have been reported for sweet cherry, table grapes and jujube [11, 12, 13 & 14].

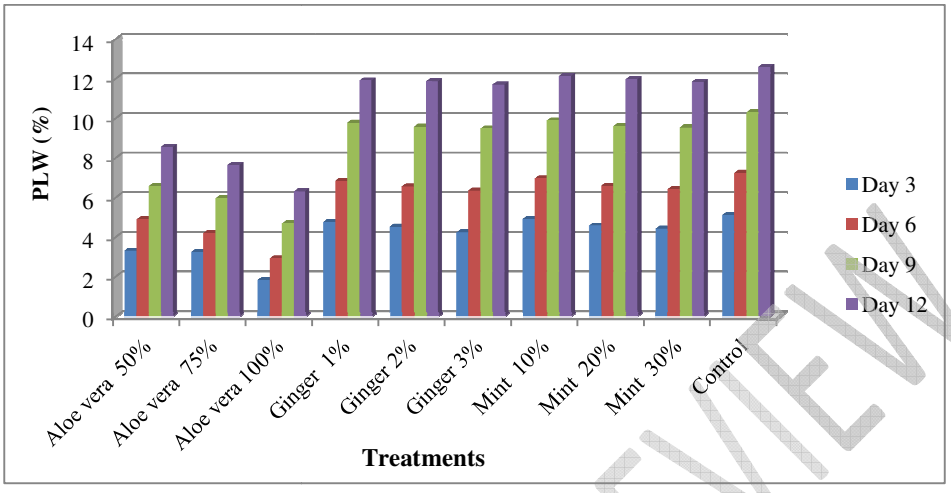

Fig.1. Effect of different bio-extracts coating on physiological loss in weight (%) in pomegranate cv. Mridula

3.2 Decay loss (%)

The data on decay loss as depicted in Figure 2, clearly shows that decay loss in pomegranate fruits was significantly influenced by the bio-extracts coating. In all the bio-extracts coating treatments, no decay loss was found up to first eight days of storage under ambient room conditions, while least decay loss, *i.e.*, 0.63 and 9.65% was observed on 9th and 12th day of storage with ginger extract 3% coating and the most decay loss, *i.e.*, 11.40 and 23.36% was recorded in untreated fruits. The pronounced effect of ginger is attributed to presence of antimicrobial compounds [15]. The coating effect of *Aloe vera* extract 100% and ginger extract 1% was similar to each other, though they reduced decay loss significantly over the uncoated fruits but remain significantly lower than ginger extract 3% coating on 9th and 12th day of storage. These results are in conformity with the findings in *Salak pondoh* fruit [16] by inhibiting the growth of *Thielaviopsis paradoxa* during storage.

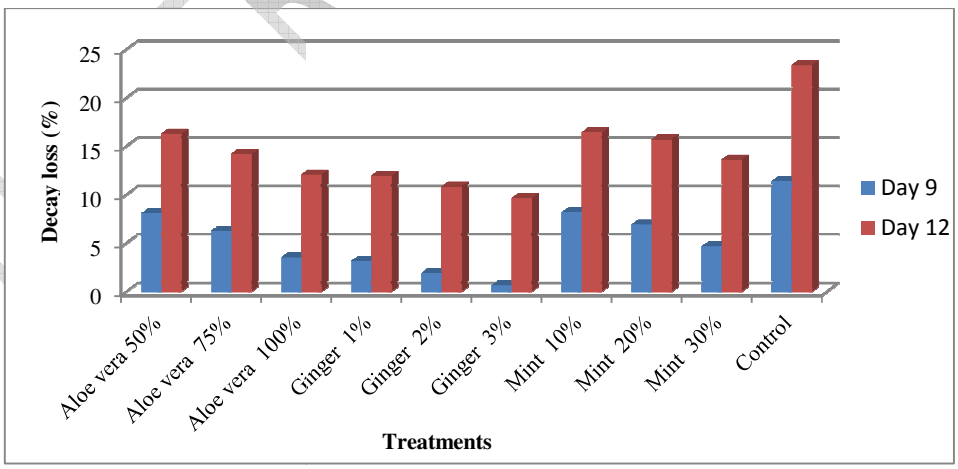

Fig.2. Effect of different bio-extract coating on decay loss (%) in pomegranate cv. Mridula

3.3 Juice content (%)

The perusal of data on pomegranate juice content (Table 1) reveals that there was a significant differences observed in juice content (%) of fruits coated with different bio-extracts at different storage

period. The maximum juice retention (47.17%) was found in fruits coated with *Aloe vera* extract 100% and the minimum in control (45.56%), which was statistically at par with juice content in fruits coated with mint extract 10% (45.75%). Moreover, reduction in juice content of pomegranate fruits at the end of storage period might be due to the excessive loss of moisture from the fruits and with the advancement of storage period, the juice content in fruits decreased gradually. The maximum juice content in pomegranate fruits (47.51%) was noticed on 0^{th} day of storage and minimum on 12^{th} day of storage (44.00%) under ambient room conditions. The interaction of the bio-extracts coating and storage duration was found non-significant with respect to juice content of pomegranate fruits.

Table 1: Effect of bio-extracts coating on juice content (%) of pomegranate cv. *Mridula*

Treatments	Storage period (days)					Mean
	0	3	6	9	12	
***Aloe vera* extract 50%**	47.51	47.33	46.65	46.32	45.18	**46.60^{c}**
***Aloe vera* extract 75%**	47.51	47.42	47.16	46.7	45.6	**46.88^{b}**
***Aloe vera* extract 100%**	47.51	47.45	47.32	47.14	46.42	**47.17^{a}**
Ginger extract 1%	47.51	47.12	46.45	44.88	43.05	**45.80^{e}**
Ginger extract 2%	47.51	47.14	46.36	45.24	43.11	**45.87^{e}**
Ginger extract 3%	47.51	47.37	46.55	45.37	43.82	**46.12^{d}**
Mint extract 10%	47.51	46.98	45.99	45.07	43.2	**45.75^{ef}**
Mint extract 20%	47.51	47.05	46.00	45.13	43.36	**45.81^{e}**
Mint extract 30%	47.51	47.09	46.01	45.22	43.35	**45.84^{e}**
Control	47.51	46.79	45.72	44.89	42.87	**45.56^{f}**
Mean	**47.51^{a}**	**47.17^{b}**	**46.42^{c}**	**45.60^{d}**	**44.00^{e}**	

*Any two means followed by same letter did not differ significantly from each other at p=0.05 level of significance (L.S.D.). Treatments and storage period interaction was non-significant.

3.4 TSS to acid ratio (%)

The TSS to acid ratio of pomegranate fruits with different bio-extracts coating (Table 2) was noted minimum on the 0^{th} day (31.09%) of storage and maximum on 12^{th} (35.48%) day of storage due to the loss of moisture from the fruits with the advancement of storage period under ambient room conditions. The total soluble solids to acid ratio (33.88%) was found maximum in control fruits and the minimum TSS to acid ratio (32.17%) in fruits treated with *Aloe vera* extract 100%.

Table 2: Effect of bio-extracts coating on TSS to acid ratio (%) of pomegranate cv. *Mridula*

Treatments	Storage period (days)					Mean
	0	3	6	9	12	
***Aloe vera* extract 50%**	31.09	31.93	32.43	33.76	35.00	**32.50**
***Aloe vera* extract 75%**	31.09	31.12	32.36	32.88	34.05	**32.43**
***Aloe vera* extract 100%**	31.09	31.09	31.33	32.38	33.49	**32.17**
Ginger extract 1%	31.09	32.10	32.64	34.39	35.80	**33.66**
Ginger extract 2%	31.09	32.00	32.50	34.32	35.70	**32.76**
Ginger extract 3%	31.09	31.14	32.45	34.27	34.68	**32.69**
Mint extract 10%	31.09	32.95	33.66	35.48	36.92	**33.78**
Mint extract 20%	31.09	32.12	32.74	34.46	35.73	**33.68**
Mint extract 30%	31.09	32.00	32.60	34.34	35.60	**32.76**
Control	31.09	33.02	33.73	35.55	37.10	**33.88**
Mean	**31.09**	**32.00**	**32.55**	**34.17**	**35.48**	

3.5 Ascorbic acid (mg/100 g):

The data presented in Table 3 reveal that the ascorbic acid content of pomegranate fruits influenced significantly due to bio-extract coating and storage period, while the interaction between the treatments and storage periods was found statistically not-significant. Under ambient room conditions, the maximum ascorbic acid was recorded in fruits coated with *Aloe vera* extract 100% (12.82 mg/100 g). The minimum ascorbic acid was recorded from untreated fruits (12.03 mg/100 g). This might be due to the low oxygen permeability of coat, which delayed the deteriorative oxidation reaction of ascorbic acid content [17]. Similar results were obtained during storage in nectarines [18], guava [19], oranges [20], longan [21] and jujube [22] fruits coated with *Aloe* gel. *Aloe* coating reduces respiration and retains ascorbic acid in the fruits [23]. The progression of storage period significantly decreased ascorbic acid content. It was recorded maximum on 0th day of storage (13.08 mg/100 g), which was statistically at par with ascorbic acid on 3rd day of storage (12.85 mg/100 g) and minimum on 12th day (11.68 mg/100 g) of storage.

Table 3: Effect of bio-extracts coating on ascorbic acid (mg/100 g) of pomegranate cv. *Mridula*

Treatments	Storage period (days)					Mean
	0	3	6	9	12	
***Aloe vera* extract 50%**	13.08	12.9	12.81	12.37	11.94	**12.62^{b}**
***Aloe vera* extract 75%**	13.08	12.92	12.84	12.45	11.96	**12.65^{b}**
***Aloe vera* extract 100%**	13.08	13.00	12.9	12.68	12.43	**12.82^{a}**
Ginger extract 1%	13.08	12.80	12.03	11.79	11.63	**12.27^{ef}**
Ginger extract 2%	13.08	12.83	12.15	11.86	11.74	**12.33^{de}**
Ginger extract 3%	13.08	12.88	12.51	11.99	11.83	**12.46^{cd}**
Mint extract 10%	13.08	12.76	12.33	11.96	11.28	**12.28^{ef}**
Mint extract 20%	13.08	12.77	12.41	12.24	11.55	**12.41^{cd}**
Mint extract 30%	13.08	12.81	12.50	12.31	11.73	**12.49^{c}**
Control	13.08	12.84	12.09	11.43	10.70	**12.03^{g}**
Mean	**13.08^{a}**	**12.85^{a}**	**12.46^{b}**	**12.11^{c}**	**11.68^{d}**	

*Any two means followed by same letter did not differ significantly from each other at p=0.05 level of significance (L.S.D.). Treatments and storage period interaction was non-significant.

3.6 Anthocyanin content (mg/100 g)

The mean data pertaining to anthocyanin content of pomegranate fruits with different bio-extracts coating are presented in Table 4 and revealed significant effect of storage period and different bio-extracts coating on anthocyanin content. The variation in anthocyanin content due to interaction between packaging materials and storage conditions was statistically non-significant. Fruits coated with *Aloe vera* extract 100% recorded least anthocyanin content (13.98 mg/100 g) and highest in uncoated control fruits (14.29 mg/100 g). The fruits coated with *Aloe vera* extract 50 and 75%, ginger extract 1 and 2% and mint extract 10 and 20% were found statistically at par with each other. Similar results have also been reported in grapes [24], papaya [25] and pomegranate [26]. Under ambient room conditions, anthocyanin content increased significantly with the increase of storage period and the minimum anthocyanin content was recorded on 0th day (13.86 mg/100 g), which was statistically at par with anthocyanin content on 3rd day (13.92 mg/100 g) and the maximum on 12th day (14.52 mg/100 g), which was statistically at par with anthocyanin content on 9th day (14.30 mg/100 g) of storage. The anthocyanin content was more pronounced in uncoated fruits than the coated fruits, it may due to the fact that the bio-extract coating reduce the transpiration loss, as reflected from physiological loss in weight, thus in coated fruits cell, higher water content was retained, so reflecting less anthocyanin content as compared to uncoated fruits, where anthocyanin concentrated within individual cell due to higher water loss.

Table 4: Effect of bio-extracts coating on anthocyanin content (mg/100 g) of pomegranate cv. *Mridula*

Treatments	Storage period (days)					Mean
	0	3	6	9	12	
***Aloe vera* extract 50%**	13.86	13.92	14.01	14.17	14.35	**14.06^{g}**
***Aloe vera* extract 75%**	13.86	13.93	13.99	14.16	14.29	**14.05^{g}**
***Aloe vera* extract 100%**	13.86	13.91	13.95	14.00	14.2	**13.98^{h}**
Ginger extract 1%	13.86	13.93	14.14	14.39	14.62	**14.19^{bcd}**
Ginger extract 2%	13.86	13.92	14.06	14.35	14.59	**14.16^{cde}**
Ginger extract 3%	13.86	13.87	14.00	14.30	14.49	**14.10^{fg}**
Mint extract 10%	13.86	13.96	14.26	14.42	14.68	**14.24^{ab}**
Mint extract 20%	13.86	13.92	14.23	14.36	14.63	**14.20^{bc}**
Mint extract 30%	13.86	13.86	14.07	14.31	14.60	**14.14^{def}**
Control	13.86	14.00	14.36	14.51	14.72	**14.29^{a}**
Mean	**13.86^{d}**	**13.92^{cd}**	**14.11^{bc}**	**14.30^{ab}**	**14.52^{a}**	

*Any two means followed by same letter did not differ significantly from each other at p=0.05 level of significance (L.S.D.). Treatments and storage period interaction was non-significant.

3.7 Organoleptic rating

The data pertaining to organoleptic rating of pomegranate fruits are presented in Table 5. The organoleptic rating of pomegranate fruit differed with different bio-extracts coating and the rating decreased gradually with the advancement of storage period. Under ambient room conditions, the fruits coated with *Aloe vera* extract 100% illustrated the highest organoleptic rating (8.0), while the least rating (7.1) was given to the fruits kept untreated. On 0th day (8.5), pomegranate fruits had the maximum organoleptic rating and minimum on 12th day (6.1) of storage. During storage, the judging panel found that flavor was satisfactory in *Aloe vera* coated fruits as compared to other coating treatments and it was unsatisfactory in control fruits. In table grapes, the panelists also preferred the coated berries with *A. vera* gel, because of their crunchiness, firmness, juiciness and visual aspects as compared to uncoated fruits [11], as well as in sweet cherry [12], which looked shiny and attractive. Similar to our result the same effect was also reported in papaya [25] and table grapes [24].

Table 5: Effect of bio-extracts coating on Organoleptic rating of pomegranate cv. *Mridula*

Treatments	Storage period (days)					Mean
	0	3	6	9	12	
***Aloe vera* extract 50%**	8.5	8.2	8.0	7.5	6.5	**7.7**
***Aloe vera* extract 75%**	8.5	8.2	8.1	7.7	7.0	**7.9**
***Aloe vera* extract 100%**	8.5	8.4	8.2	7.8	7.3	**8.0**
Ginger extract 1%	8.5	8.1	7.5	6.7	6.0	**7.4**
Ginger extract 2%	8.5	8.1	7.6	6.9	6.0	**7.4**
Ginger extract 3%	8.5	8.2	7.8	7.0	6.1	**7.5**
Mint extract 10%	8.5	8.0	7.3	6.6	5.5	**7.2**
Mint extract 20%	8.5	8.0	7.5	6.7	5.7	**7.3**
Mint extract 30%	8.5	8.0	7.6	6.9	5.9	**7.4**
Control	8.5	7.8	7.0	6.5	5.5	**7.1**
Mean	**8.5**	**8.1**	**7.7**	**7.0**	**6.1**	

4. Conclusion

The loss in weight of pomegranate fruits was initiated from 3rd day onwards under ambient room conditions and *Aloe vera* extract 100% found as the most effective coating substance for reducing the physiological loss in weight, while amongst all the treatments, fruits coated with ginger extract 3% had least decay loss. Quality parameters such as juice content, ascorbic acid decreased, while total soluble solids to acid ratio and anthocyanin content increased with the advancement of storage

period. Variation in such parameters played a very crucial role in determining the optimum storage quality of pomegranate fruits. The maximum juice content and ascorbic acid while least total soluble solids to acid ratio were observed in fruits coated with *Aloe vera* extract 100% throughout the storage period. Moreover, the overall acceptability of pomegranate fruits was also found superior in pomegranate fruits coated with *Aloe vera* extract 100%.

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